



Watershed Systems

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September 8, 2006

Members of the

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

CENTRAL VALLEY REGION and Messers James Rohrbach and James Pedri

415 Knollcrest Drive, Suite 100, Redding, CA 96002

By email: [jrohrbach@waterboards.ca.gov](mailto:jrohrbach@waterboards.ca.gov)

Re: 22 September Board Meeting :Tentative Waste Discharge Requirements and Monitoring/Reporting Program For Calpine Siskiyou Geothermal Partners, L.P. and the U.S. Department of Agriculture, Forest Service, and U.S. Department of Interior, Bureau of Land Management Glass Mountain Unit Exploration and Development Projects in Siskiyou County.

Attached is the text of a follow-up statement prepared for the Pit River Tribe and the Mt. Shasta Bioregional Ecology Center. I will again make a Power-Point presentation at the Hearing on September 22nd. That oral presentation will supplement and illustrate the bases of these written comments. In the Power-Point I will include geologic maps and figures that are the bases of my opinions. I ask that this report be included in the record and distributed to the members of the Board prior to the hearing.

I am a retired University of California professor and a California Registered Geologist and hydrologist. My PhD is in Geology and Geophysics from UC Berkeley. I have consulted on issues of geothermal development in New Mexico and California since 1969. My areas of specialization are water quality and volcanic geology and I consult for the Regional and State Boards. My CV was attached to my earlier May 2006 submission.

Sincerely,

Robert R. Curry

## Introduction

This testimony follows what I presented to you on May 3, 2006. Subsequent to that hearing your Water Board staff forwarded to me a draft monitoring proposal submitted by Calpine's consultant. To attempt to respond to staff request that I review the Calpine proposal, I prepared a request to meet and confer with Calpine. Through proper channels, I requested either a meeting or a minimal exchange of information that I deemed necessary to evaluate the adequacy of the monitoring proposal. My request, forwarded through Water Board staff, was denied by Calpine. I was willing to maintain privacy constraints on the proprietary data as is common in some cases for groundwater information exchange. A copy of that request for information exchange is attached.

I have also developed a substantial information base on Enhanced Geothermal Recovery techniques (EGS) currently in use, including acid treatments of geothermal wells, and have attempted to learn as much as possible about both the science and reasoning behind the belief of other parties that the geothermal production aquifer is isolated from the regional Medicine Lake Volcano aquifer and not subject to cross-contamination. It was this latter regional aquifer that discharges at Fall River Springs to become an important part of the California Water Project deliveries that was a focus of my earlier testimony to you.

To recapitulate part of that earlier testimony, Fall River and its springs represent the largest source of water in the State of California that is derived from perennial springflow. The Central Valley Regional Water Quality Control Board has responsibility for this very clean geothermally warmed water source that is believed to be recharged from snowmelt upon and through the Medicine Lake volcano. This water enters the Pit River from whence it discharges into the Sacramento River system and into the California Aqueduct to be carried to the farthest reaches of Southern California. Fall River Spring is one of the largest springs in the United States (Meinzer, 1927). At least a portion of this water may be derived from precipitation in the North Coast Water Board Region. You are being asked to approve Waste Discharge Requirements for a geothermal exploration and development program that may contaminate and alter both the recharge and heat flow to this major California water resource.

## Monitoring and Risk Analysis

As pointed out in my prior testimony, the applicants propose that a geologic "cap" or impermeable covering separates the surface snowmelt and the groundwater that it feeds from the deeper hot groundwater that is the object of geothermal development and accessed only through deep drilling. Thus, they postulate that whatever is injected deep into the geothermal reservoir cannot contaminate Medicine Lake itself or the surface springs around it. The evidence for this sealing cap on the hot fluids is apparently derived from proprietary drill records, from comparative chemistry on shallow and deeper groundwater encountered in wells, and from isotopic differences between water in the deep wells and that which maintains Medicine Lake itself and surrounding springs. As will be discussed later, there is no assurance that the cap is everywhere impermeable or that it will remain impermeable during the life of this field. Medicine Lake Volcano geothermal exploration wells apparently intersects a thick clay layer just above the hot geothermal reservoir. Such hydrothermal alteration zones are common around geothermal zones. Hot fluids react with minerals in the granitic bedrock to form clay minerals.

Because Medicine Lake Volcano is not characterized by extensive hot springs, geysers or fumaroles common in other geothermal areas, the assumption is apparently made that there is no present avenue for bringing deep geothermal water to the surface or, by extension of this observation, to allow mixing of deep water with shallow contemporary groundwater that supports the lakes, forest, and springs. I believe I understand the basis for this logic for the caldera lease area itself, but it does not extend to Fall River Springs or other water resources that lie beneath and surround the volcanic mountain area. The Medicine Lake volcanic area is quite unique in that there are no through-flowing or perennial streams. The mountain is so porous that no matter how much snow may melt or how much rain a summer thundershower may bring, it is readily absorbed into the pumice, volcanic ash, and vesicular volcanic flow rocks.

Consulting reports submitted to support the EIR suggest that snowfall on the volcano itself is insufficient to account for Fall River Springs and that this great groundwater source is passing through lava tubes or very porous beds under the lava and is derived from some far off source. Thus, they reason, contamination is improbable from activities near the summit caldera of the volcano. This is simply very improbable. Robert Mariner and his USGS colleagues have shown that more than adequate snowmelt is available on the porous volcano itself to supply the flow measured at Fall River. (Lowenstern et al, 1998) The highest snowmelt is from the area where geothermal exploration and development is underway at both Telephone Flat and Fourmile Hill. New snow measurements are being proposed for the Medicine Lake Caldera area as part of the monitoring plan *after* exploration and development are underway. I find this similar to a group of prison guards arguing about the quality of a lock that was found broken after the inmates escaped. In my opinion, the two snow-water measuring stations at Medicine Lake (Doublehead Ranger District station with seasonal data back to 1938, and the Medicine Lake Snow Pillow with hourly data back to 1984) are adequate to estimate recharge from the caldera area. The proportionally weighted data for the entire volcano presented by Lowenstern et al in 1998 is sufficiently accurate for assessment of risks associated with these WDRs. Only snow chemistry needs to be augmented.

The so-called clay caps or aquitards are speculative. The deeper geothermal water is of meteoric origin, so it has to get there from rain and snow somehow (Lowenstern, 2003, p. 2). The geophysical drill logs may be interpreted to indicate clay layers but in a developing volcanic field, such less permeable units would be sinking and stretching and may not maintain integrity. Regional fracturing through the volcanic crater summit area is occurring along north-south alignments, and the surface has been demonstrated to be sinking through general east-west tectonic extension (Durisin, et al, 2002; Poland, et al, 2006). If a clay-cap does exist at the present time, it cannot be expected to persist in this active tectonic setting and if the cap is leaking, we would expect it to allow some flow to the south, where, indeed, the few surface springs are found today. Further, geothermal and eruptive activity has occurred in the very recent geologic past, (Lowenstern, 2003) and there is no reason to presume it will not continue in the near future. My primary concerns are not vertical permeability but horizontal leakage beneath the cap to allow intermixing with regional groundwater. If leaks propagate vertically and form vents in the caldera, those can be ultimately detected, but horizontal leakage through the regional tectonic alignment may have no evident surface manifestation.

My request to Calpine for information was based on a need to assess the contiguity of the clay cap based on drill records that span the regional fracture system

and east-west extensional pattern in order to determine an appropriate/adequate hydrologic monitoring plan that would protect both regional and local groundwater resources. Are there enough wells or other geophysical information sources to reasonably infer that there is not a weakness or break in the capping unit that could allow fluids to leak into the regional aquifer or aquifers that may feed Fall River Springs? Can a model be developed that insures that any leakage of deep groundwater can only enter the regional freshwater aquifers at a rate and dilution so as to render industrial acid residues benign in the California Aqueduct? I will address these questions below and propose a set of monitoring requirements that are comprehensive to accommodate the missing data base.

The proposed monitoring plan initially developed by the US Geological Survey (Schneider, T.R. and William D. McFarland, 1995, Hydrologic Data and Description of a Hydrologic Monitoring Plan for Medicine Lake Volcano, California. U.S. Geological Survey Open-File Report 95-750) and forming the basis for Calpines' proposal focused on Medicine Lake and its summer cabins and campgrounds only. The need for deep wells to assess movement of possible contaminants at around the geothermal reservoir, and to assess the possibility that deeper and shallower groundwater may intermix is critical. Although not the purpose of the hydrologic monitoring plan, the deep well monitoring would also establish that there is adequate reserve production capacity to protect the shallower aquifer water that will be used to supplant deep geothermal water through pumping to increase the life of the resource. BLM and the Central Valley Board both suggested deep wells, suggesting that one be located near an acid injection well [Group Oversight Requirements letter exchange]. I would concur, but also recommend deeper wells at the margin or just beyond the margin of the lease area along the alignment of the regional faults. These could test the integrity of the clay cap outside the caldera and detect fluids moving radially outward and/or upward from the deep geothermal zone.

Much better basic geologic and hydrologic investigation needs to be done to develop a valid monitoring plan that protects water resources. Such work can be done in a period of 2-3 years. Without access to the basic Calpine maps and data or at least a meeting with their technical people, I cannot outline a minimal safe monitoring plan. Minimally, it is necessary to monitor around the sumps that received acidized fluids and along the periphery of the presumed hydrothermally-altered clay-cap zone.

***“Just Draño”:*** Applicants would have you believe that use of hydrofluoric acid in combination with other acids to develop an economically profitable geothermal field is as benign as using Drano® in your kitchen sink (see hearing record for May 4, 2006, pp. 66-69). It is true that some geothermal wells with declining production due to reduced permeability can be restored for a short period of time with acids and other forms of EGR. But in the case of the Medicine Lake Highlands, that “enhancement” is apparently needed simply to get to a production stage and prove economic feasibility. Drano is, of course, highly caustic and not suitable for drinking water, but HF is even more hazardous.

The same processes that are being called upon to isolate the deep geothermal aquifer from today's' shallower snowmelt-fed groundwater also are continually sealing off fracture porosity and permeability in the reservoir rocks. EGR is necessary to open the fractures. Hydrofluoric and hydrochloric acids, often used with a bulking agent, are pumped into the well and react with the silica and carbonate cement that seals the fractures. The combination of acids is forced under pressure into the fractures to dissolve cementing silicate and increase porosity and, it is hoped, permeability (some

processes are patented (<http://www.freepatentsonline.com/6896058.html>; <http://www.freepatentsonline.com/6555505.html>). The HF in contact with granitic or volcanic rocks forms silicon tetrafluoride gas that exerts great expansive pressure. It will react with calcium carbonate that also seals the fracture permeability to reseal the system.

The basic problem is that hydrofluoric acid is extremely toxic, even at a few parts per million. A materials safety sheet for a pure form of more dilute HF used to etch silicon wafers is available from its manufacturer Honeywell as: <http://www.honeywell.com/sites/docs/DD000HHXLNPYFWG0GHC021R0TVT5H7AF60803114547318.pdf>. Hazards are reflected in description of the trucks used to deliver this material:

Honeywell manufactures and ships 49% HF from its Geismar, Louisiana and Amherstburg, Ontario production facilities. Aqueous HF is delivered in bulk quantities via Honeywell trucks and custom designed trailers. Honeywell operates the largest Aqueous HF transportation fleet in North America with over 20 trailers in service. Each truck and trailer "unit" is equipped with satellite tracking capability, emergency shutdown devices, and other state-of-the-art features. The satellite tracking system can pinpoint the unit's location at all times and allows for constant two-way communication. Two man driver teams, regardless of travel distance, operate each delivery unit. All our drivers are Honeywell professionals, not "common carriers". Every driver is required to complete extensive training in the safe handling and delivery of aqueous HF before they go "on the road". 49% HF is a hazardous, corrosive acid that demands rigorous safety considerations in its use and handling. Both liquid and vapor can cause severe burns to all parts of the body. Specialized medical treatment is required for any exposure to HF.

We might postulate that Calpine does not propose to transport liquid HF to the site, because the Halliburton proposal submitted as an example of proposed acidization states that it will be "mixed on the fly" and that 40,000 gallons of a proprietary form of HF called "Silica Scale Acid" may be applied. This proprietary product appears to have been developed for totally different applications in sandstone where silica scale is building on pipes (April, 2002 "Glass Mountain Enhanced Permeability Project proposal submitted by Calpine-Siskiyou Geothermal Partners LP to DOE). Since the BLM has redacted the Sundry Notice and withheld all information about the acidization of well 31-17, we cannot clearly define the acidization process and there is no environmental analysis, even for the one well already approved.

Hydrofluoric acid passes into the human body through skin contact or ingestion and accumulates without immediate reaction. Even if delivered in anhydrous (dry) form and mixed on-site, the water soluble product remains very dangerous. Because acid treatments of wells are not all the same and the proposed Calpine treatments are more risky and will have to be repeated many times during the life of a well, thorough environmental analysis **before** further treatment was originally recommended by BLM and is now being required by the North Coast Regional Board for wells in their jurisdiction. BLM said they would only allow acidization of **one** well, 31-17 because it has already been approved. This approval was by the Assistant Secretary of Interior, Rebecca Watson. Presumably, BLM considered only a single acid enhancement as part of an exploration phase. Any further environmental analysis must assess risks of contamination to both local and regional aquifers. Just because Siskiyou County Air Pollution Control District (SCAPCD) signed off does not mean that it is safe or routine. As many as 40 wells may need to be acidized to effect full production if initial tests are successful.

***Proposed acid treatments not routine:***

Use of HF acidization in geothermal fields adjacent to major regional economically-important domestic aquifers is not at all “routine”. The regional aquifer is designated as *High Quality Waters of the State*. Your situation is very different from the Geysers, Mammoth, Imperial Valley or Coso where the geothermal fields are not adjacent to domestic water sources for a large percentage of the State’s residents. It is true that the rock into which the acid is injected will react with the acid to neutralize some of it. It is also true that a long coiled tubing system will probably be used to try to deliver most of the acid to a production zone only. But the acid reacts exothermically and creates great pressure that can rupture well seals and casings. Its use is a rather desperate and very expensive measure to attempt to make the existing and future wells pay off for the various companies that have invested in these leases. Proof of economic potential is a necessary condition of the federal leases. Calpine is asking that the federal government cover a major portion of the cost of the acid treatment experiments, and admits that such activity is new for marginal fields in the United States (DOE, Idaho Office, 2002, *op cit*, Required Forms and Documents). It has been tried in the Philippines under very different geologic conditions without associated risks to regional aquifers.

Dr. Tim Rose at Livermore Labs was quite surprised to learn of the proposed and claims of past acidization activity<sup>1</sup>. Rose and Davisson were asked by the Central Valley Board to assess sources of Fall River Springs water about 10 years ago, and prepared a report for your Board at that time. They have not published the data they collected on dissolved noble gases and carbon isotopes but Dr. Rose explained to me in a telephone call in September, 2006, that there is a “clear linkage” between the springs and the caldera area. He suggested that the Board proceed with “clear caution and be certain that these springs are not damaged”. A partial report on their base work is published as Davisson and Rose (1997) but this does not include the analyses done for you.

## Monitoring Recommendations

Much better basic geologic and hydrologic investigation needs to be done to develop a valid monitoring plan that protects water resources. Based on the May, 2006 *Glass Mountain Energy Center (GMEC), Fourmile Hill & Telephone Flat Projects, Monitoring and Mitigation Plans, Calpine, Hydrology*, we see that there is simply no concept of what the hydrologic base system looks like so few or no appropriate monitoring proposals could be developed. The WDRs are the first line of defense for water quality protection for this geothermal field. There is no question that the Regional Board has responsibility for both ground and surface water. Sec. 1021. Federal exemption from State water laws states<sup>2</sup>:

Nothing in this chapter shall constitute an express or implied claim or denial on the part of the Federal Government as to its exemption from State water laws.

Noticeably absent in the proposed monitoring plan put forth by Calpine is any discussion of the hydrogeologic systems being monitored other than in a “shallow,” “intermediate,” and “deep” context. The current hydrogeologic monitoring system must take into consideration both horizontal and vertical flow components as well as equal-

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<sup>1</sup> BLM has denied information about previous acid activities at Medicine Lake. All we have is a redacted Sundry Notice approving it for well 68-8 and 31-17.

<sup>2</sup> (Pub. L. 91-581, Sec. 22, Dec. 24, 1970, 84 Stat. 1573.) Title 30 – Mineral Lands and Mining.— Chapt. 23 – Geothermal Steam and Associated Geothermal Resources.

density and saline density fluids. There is no where specified<sup>3</sup> either in the monitoring plan or support information (EIS/EIR) or USGS publications supporting the plan, the nature of the hydrogeologic units – whether water table or confined conditions, confining units and corresponding boundary conditions defining each system, nor the association of each vertical system to the other, nor the potential pathways contamination could occur from each of the proposed facility or operational features.

No permeabilities or hydraulic conductivities, storage properties, potentiometry of each system, flow directions keyed to each operational facility feature, etc. are discussed anywhere and the resulting monitoring system components reflect a mere minimization of effort and convenience of placement almost totally unrelated to the target features needing monitoring protection.

- 1) Re: Drilling of geothermal wells and groundwater use in the Arnica sink area – How are groundwater withdrawal impacts and quality impacts being monitored to detect adverse circumstances? What is considered a negative impact from a quality and quantity perspective?
- 2) Re: Plant operation impacts – How will adverse water quality impacts from spilled geothermal or poor water quality sources be detected with the positioning of the current array of monitoring wells for the shallow and intermediate groundwater systems? How will local recharge conditions be impacted and diffuse distribution of minor spills over time be detected by the proposed monitoring network for either vertical or horizontal flow components in either the shallow or intermediate ground water zones? What constitutes a negative impact and what proactive steps will be taken to prevent rather than just monitor adverse conditions?
- 3) Wellbore leaking due to corrosion, weld or connector breaks due to formation stresses and strains over time, or other operational mishaps can occur at any depth. How does the proposed monitoring plan serve to detect these types of source-contaminants contributing to ground water quality and quantity impacts in shallow, intermediate and deep zones adjacent to the adverse well or wells? There are too few monitoring wells, not located correctly which do not meet this purpose in the current plan and as a result most of these types of impacts will go undetected.
- 4) Injector well leakage – There are too few, if any, proposed monitoring wells related to injectors. How are the proposed monitoring wells in the shallow and intermediate groundwater zones able to detect these types of leaks? A minimum of three wells is needed to properly get some idea as to flow direction and magnitude for a release into any given zone. How does having only one monitoring well in the intermediate zone serve any useful purpose other than to save effort and cost for the project? The one intermediate well proposed at each project site is next to useless without other monitoring wells in the same zone and cannot be honestly appraised as a proper due-diligent effort on the part of the lessee to be taken seriously they can detect leaks into this zone.

Section 3.0 of the plan (GMEC, 2006, p. 4-5) recounts monitoring program concepts for frequency and baseline information. Seasonal data (winter, spring, summer and fall) or quarterly monitoring should be prescribed for all ground water sampling. Continuous monitoring instrumentation should be done for the water supply wells in a separate monitoring observation well dedicated to that purpose and located adjacent to

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<sup>3</sup> Other than water table depth at 600-800 ft at Fourmile Hill in Section 3.1, 3<sup>rd</sup> paragraph.

the Telephone Flat supply well and the Fourmile supply well. Instrumentation in these observation wells should include water level, temperature taken daily at the same time of day, pH and specific conductivity. A weatherproof programmable recorder with interface should be used to safely keep the information at the well and read directly with portable surface monitoring equipment by personnel prior to operations and once the plant is operational. Remote data collection instrumentation should be placed in all monitoring wells to simultaneously collect information and preclude individual well visits to collect information.

All monitoring wells should be visited monthly (or quarterly if equipment proves reliable over time) by on-site personnel to insure proper operations. Monitoring wells and frequency of observation are not necessarily related to waste discharge requirements and it is recommended that these requirements be coordinated with the waste discharge requirements but decoupled from it for the types of other impacts to groundwater not related to waste discharges. The first paragraph requires rewording of the language in Section 3. The second paragraph of this section should be more specific as to the other springs, wells, lakes and other features to be monitored by Calpine. The promise to do this requires a definite commitment by identifying and specifying which features will be monitored (and what is being measured and why) outside the immediate project locations. We need to better define the purpose of this monitoring and goals to be achieved by and to the operation under consideration in the plan. There is no defined monitoring strategy developed for the differing components of the plan as currently written.

Section 3.1 (GMEC, second paragraph, p. 5) – How far in advance will the geology be defined prior to system design and approval by the BLM. This should have already been done in order to define proper placement of monitoring wells. How does the lessee rationalize a well location plan without proper hydrogeologic site definition suitable to allow proper design of the monitoring systems (shallow, intermediate and deep)? It has been stated in the EIS/EIR, Weiss Report and USGS reports that the site hydrogeology is complex, yet oversimplification prevails in most explanations of the monitoring philosophy or plan discussions. How has site complexity been accommodated by the current monitoring plan?

Section 3.1 (*ibid*, third paragraph, p. 5) – How do partially-penetrating wells serve the monitoring purpose of the shallow monitoring system? What is considered the bottom boundary layer or feature which defines the shallow system in the Telephone Flat Project area?

Section 3.1 (*ibid*, fourth or last paragraph, p. 5): Vague description of parameters is proposed as if the lessee has little idea what are important parameters. Part of the strategy of a monitoring plan is to express confidence about the significant quality parameters in need of monitoring. The information expressed in this paragraph indicates lessee is either reluctant or unwilling to describe unique geothermal characteristics which should be included with standard parameter lists for monitoring. This is an opportunity to describe to the regulatory authority unique parameters indicative of operational upsets which would prompt action other than routine monitoring. No suggestions, other than primary drinking water standards, means they should measure everything to find out what is important which will prompt them to get more specific here and outline a good parameter list. Later in the plan they reference the USGS water quality parameter listing (Appendix 1 to plan, p. 10-11), but this still shows they have put little thought into this plan because of their constant reliance on the USGS. This relationship needs better definition and separate activities should be emphasized. The



USGS program and association should not be considered a proxy for these operations. This is a perception issue and potential misuse of government resources (once they are in construction and operation activities) to subsidize private efforts and preclude conflicts of interest.

Section 3.2 (*ibid*, first paragraph, p. 5): Why wasn't the baseline meteorological data included in the EIS/EIR documentation? Will H<sub>2</sub>S monitoring also include personnel safety monitoring devices? How is confined space H<sub>2</sub>S monitoring being accommodated by the air monitoring plan for off site personnel, private residencies and the visiting public?

Section 3.3 (*ibid*, Geothermal Reservoir Monitoring, p. 6): The environmental portion of the data should not be considered proprietary for health and safety reasons (OSHA compliance and right-to-know law). This is abuse of this privilege by the lessee and should be challenged. Regarding USGS cooperation: coordination is fine but over-dependence or reliance on USGS should not be allowed and distinctly called out as not tolerable. This is ripe for conflict of interest issues, particular when the USGS may be called upon for dispute resolution or other issue adjudication fact finding support in the future. Any data provided the USGS should be considered public data and available to the public, with no exceptions.

Section 3.4 (*ibid*, Hot Spot monitoring, p. 6): Specific mineralogy and gas geochemistry should be specified in the plan and both vent features monitored, not just one. In addition, mineral geochemistry should be related to temperature conditions of the vents over time and included in the annual monitoring report discussed in Section "Reporting". All sampling and analysis protocols should be specifically listing or referenced and included in the plan.

Section 3.5 (*ibid*, Lakes within Medicine Lake Basin, first paragraph, p. 6-7): Ensure statements made here are also protective of the stipulation (1-4) provisions of the surface leases issued by the USFS for the SW corner of Telephone Flat lease area in vicinity of Payne Springs, the named lakes and other surface- or ground-water features (also includes non-operational areas adjacent to the project area to the west and south). Mud samples mentioned in the last paragraph of this section should be a minimum of four samples seasonally, taken from at least five locations (west and south areas, lateral area on north shore and two at deep end of lake on the east side). Comparison of these data will constitute baseline conditions. All future samples would be compared to this sample set. Locations should have GPS coordinates so repeat sampling at close to vicinity of baseline lake locations can be repeated over time. Other lakes can have fewer samples taken but same sampling philosophy for comparability of the future sampling data. All mud samples should have physical (mineralogy and grain-size distribution), and geochemical descriptions made for all samples taken. Liquid portions of samples should be decanted and water quality defined.

Section 3.6 (*ibid*, Springs in the Medicine Lake Area, first paragraph, p. 7): Before the plan is accepted, owner permission and specific springs to be monitored (listed with GPS location) should be identified and included in the plan, not just a generic listing of possible locations. Baseline should include four seasonal samplings as a minimum (four seasons) for one year, minimum). Adjustment from evaluation of the baseline can vary based on this experience. Discharge and water quality should be measured at established locations at each spring, not just sampled anywhere each time but at established locations personnel can repeat every time. Re: last paragraph (Geothermal Exploration Project) – Why are these provisions included here? There are

other wells closer to the spring area than these. There is a USFS surface lessee stipulation on all leases near, around and below Payne Springs and should be so monitored to preclude impacts.

### ***References Cited:***

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Letter forwarded to Calpine requesting information necessary to evaluate proposed monitoring plan:



Watershed Systems

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July 24, 2006

Deborah Sivas  
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Dear Ms. Sivas,

To evaluate the adequacy of the proposed monitoring plan for the Medicine Lake geothermal development Waste Discharge Requirements, I need access to the geologic and hydrologic data that the applicants should have. These data are necessary to assess the adequacy of the proposed WDRs in light of proposed drilling, testing wells, and other geothermal activities described in the tentative draft WDR.

In essence, we need to be able to review the same kinds of data that the Central Valley Regional Water Quality Control Board determined were needed for the CalEnergy Telephone Flat development proposal and EIR as per their 10 August, 1998 letter from James Pedri of the Regional Board to Patrick Griffen of the Siskiyou County Air Pollution Control District in his role as director of the CEQA Lead Agency for the original EIR. Specifically, Mr. Pedri noted that his staff needed additional information to evaluate the presence of the "capping rhyolite" or "hydrothermally altered rhyolite-dacite at the top of the geothermal system" that was purported to isolate the geothermal exploration and production zones from shallow groundwater. Pedri recommended that "well logs (lithologic and temperature gradient logs) from all wells used to evaluate the presence of this cap be made available for review". These data are critical for establishing a sound WDR monitoring plan.

Presumably, more well logs and test data are now available 8 years later. My primary task in evaluating the proposed monitoring plan is to establish that there are no large physical geographic gaps in the data that would allow alternate interpretations of the continuity of this proposed isolating cap. Thus, I need to clearly see the locations and depths of all drill sites that have defined this geologic unit. This must be done in the context of all of the historic drilling and geophysical exploration that has been accomplished in the Medicine Lake Volcano area, including areas outside the Telephone Flat Geothermal Development Project area.

As a geologist and hydrologist I work with many kinds of data, including well logs, chemical and isotopic water quality data, temperature and heat-flow data, geologic mapping, aerial and ground-based geophysical survey data, and mineralogy. Since monitoring wells and stations need not be restricted to the leases within the Glass Mountain Unit Area, I am also particularly interested in data from water wells, springs, and geophysical records from prior lease holders and for non-federally controlled operations on the flanks of the volcano. Data that update the USGS reviews (Open File Reports 95-750, 98-2, and 98-777) that can serve to evaluate shallow and deep aquifer recharge and isolation from each other and from geothermal development operations will assist in establishing WDRs that protect water resources and serve to define the aquifer systems that exist in the geothermal development area.

In summary, the following information is minimally requested in order to evaluate the adequacy of the proposed monitoring plans for the Medicine Lake geothermal development Waste Discharge Requirements:

1. A map or maps showing the locations of all bore holes or wells (active or abandoned) that may provide relevant information on subsurface conditions that define conditions that serve to isolate geothermal areas from important fresh-water aquifers. Well numbers are adequate if the Township information is also included for each well number.
2. Lithologic logs of wells where available, including depth and lithology information as well as core recovery and circulation notations where present.
3. Temperature logs or spot temperature data as a function of depth that support hypotheses of isolation of geothermal resources from adjacent water supply aquifers.
4. Bottom-hole pressure and temperature data that provide a baseline for periodic monitoring programs.
5. E-log data where relevant to the questions of aquifer isolation or that have been interpreted to indicate such isolation.
6. Geophysical (resistivity, geomagnetic, infra-red) information that supports the aquifer and/or hot-rock isolation parameters.
7. Any other significant data such as seismic analyses or heat flow or fault mapping that supports the safe separation of geothermal development areas from regional and local aquifers. These may include tracer studies, borehole self-potential logs, radon anomalies, gravity or microgravity studies, noble gas studies, fracture mapping, reservoir permeability studies, magneto-telluric studies, and other published and unpublished studies.

I remain willing to work with applicants and/or the Regional Board to review these data.

Respectfully Submitted

Robert R. Curry

Hydrologist and Registered Geologist